Application of Biodegradable Mulches in Day-Neutral Strawberry Grown in Western Washington

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ABSTRACT

Biodegradable mulches (BDMs) were introduced as an alternative to polyethylene (PE) mulches, which have economic and environmental challenges regarding costly removal and disposal. Biodegradable mulches may provide the same horticultural benefits as PE mulches, but are engineered to degrade in soils upon incorporation. Yet, BDMs have undergone limited testing, including with day-neutral strawberry (*Fragaria* × *ananassa*) typically grown with PE mulch in plasticulture. The objective of this study was to evaluate whether BDMs are suitable for day-neutral strawberry production, with regional specificity to western Washington. To accomplish this, a randomized complete block split plot experimental design was established in Spring of 2014 and 2015 at the Washington State University Northwestern Washington Research and Extension Center (NWREC) located in Mount Vernon, Washington. The study consisted of five main plot treatments, replicated four times. Treatments included a: 1) starch-based BDM; 2) prototype BDM; 3) cellulose-based BDM; 4) PE positive control; and 5) a bare ground negative control. Cultivar was the split plot factor and consisted of 'Albion' and 'Seascape'. Data collected includes crop yields, in-season mulch deterioration and intactness [recorded as percentage visual intactness (PVI)], and in-soil mulch degradation. Yields were on average greater for 'Seascape' than 'Albion'. In both years of the study, yields were similar among the starch, prototype, and cellulose BDMs for 'Seascape' and 'Albion', while overall yields tended to be reduced for both cultivars in the bare ground plots. For PVI, the starch and cellulose BDMs performed similarly in 2014 and together averaged 90% PVI compared to 98% PVI for the PE control by Sept. 30 (the last date of PVI data collection in 2014 and 2015). The cellulose BDM deteriorated more rapidly in 2015, largely due to the effects of strong winds, and had a PVI of 64% by Sept. 30. The starch BDM and PE mulch performed similarly in 2015, with 93% and 97% PVI by Sept. 30, respectively. The prototype BDM deteriorated rapidly in 2014 (7.5% PVI by Sept. 30) and was replaced with a different formulation by the manufacturer in 2015 that had longer persistence in the field (62% PVI by Sept. 30). Evaluations of in-soil mulch degradation are ongoing. Results to date demonstrate BDMs perform differently based on their formulation, but are suitable for day-neutral strawberry production in western Washington.

INTRODUCTION

- Growers use agricultural mulches to suppress weeds, conserve soil moisture, modify soil temperature, shorten time to harvest, and increase crop yields and quality.
- PE mulch use in agriculture has increased dramatically in recent years.
- However, removal and disposal of plastic mulch poses both financial and environmental concerns (Fig. 1)
- High disposal costs cause some growers to stockpile, bury, and/or burn plastic mulch.
- BDMs are a potential solution to the disposal challenges of plastic mulches. These materials should biodegrade safely following soil incorporation.
- The objective of this project is to evaluate the suitability of BDMs in day-neutral strawberry production within the maritime climate of Washington State, with an emphasis on meeting organic standards.

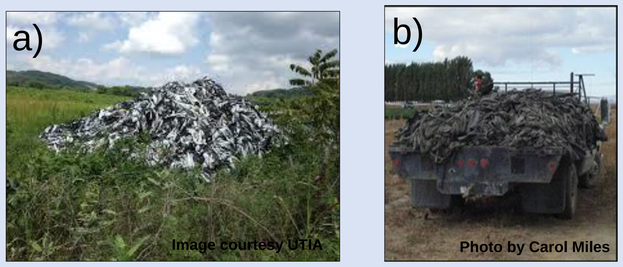

Figure 1. Disposal difficulties of PE mulch. a) Stockpiling plastic mulch and b) mulch ready for transport to a recycling facility.

METHODS & MATERIALS

A randomized complete block split plot study consisting of five mulch treatments (main plot treatments) and two day-neutral strawberry cultivars (subplot treatments) was initiated in May of 2014 at Washington State University NWREC in Mount Vernon. Cultivars of day-neutral strawberry were 'Albion' and 'Seascape'. Raised bed plots were constructed and bare-root plants transplanted in May 2014 and June 2015. Main plots were 6.1 m long and 1.2 m wide. Cultivar subplots were planted within main plots, each subplot measuring 3.05 m long. Plants were drip irrigated and fertigated weekly with 0.57 kg N/ha starting at establishment, flowers were removed early in the season and runners were continuously removed. After the cropping season, the BDMs were tilled into the soil.

Main Plot Treatments:

1. Corn starch-based BDM (0.8 mil)
2. Fermentation product prototype BDM (1.0 mil)
3. Cellulose-based BDM (13.8 mil)
4. Polyethylene (PE) plastic (positive control) (0.85 mil)
5. Bare ground (negative control)

Data Collected:

- Yield data collected at each harvest, approximately three times per week in late summer (Fig. 2)
- In-season mulch deterioration twice per month (Fig. 3, percentage of rips, tears and holes in 0.6 m x 0.9 m area; labeled Percent Visual Intactness [PVI])
- Weed suppression twice per month (percentage of weed canopy in 0.6 m x 0.9 m area; not presented)
- In-soil mulch degradation collected every six months after tilling mulch into the ground (not presented)

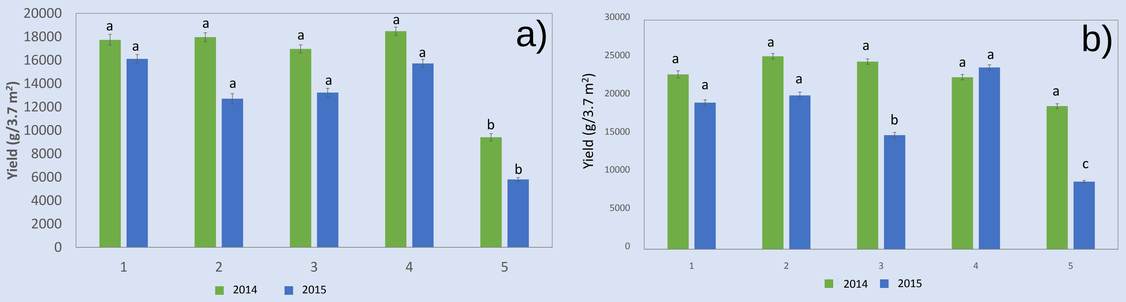

Figure 2. Yield of a) 'Albion' and b) 'Seascape' grown with five mulch treatments in 2014 and 2015. Each number corresponds to the mulch labeled above. Standard error bars denote variation within treatments. Letters of significance, displayed above each column, denote the differences between treatment means within that year as determined by Tukey's HSD (α = 0.05). *Note: The y-axis yield scales are different for 'Albion' and 'Seascape'.

Figure 3. Percent Visual Intactness (PVI) of four mulch treatments (three BDMs and one PE mulch, bare ground plot excluded) for a) 2014 and b) 2015. Quantifies amount of soil exposure due to rips, tears, and holes in the mulch; a higher percentage equals a more intact mulch. Treatment numbers in the key correspond to the mulch treatments labeled above. Asterisks (*) represent a statistical difference between mulch PVI means at that date (Tukey's HSD, α = 0.05).

PRELIMINARY RESULTS

- 'Seascape' yielded more than 'Albion', on average (Fig. 2).
- Yields were greater in 2014 than 2015, likely due to weather and increased weed pressure at the 2015 site (2014 and 2015 strawberry BDM plots were in different fields).
- In 2014, there was no significant yield difference between mulches. The bare ground treatment yielded less.
- In 2015, the corn starch and fermentation product BDMs yielded comparably to PE mulch. The cellulose-based mulch and bare ground treatment yielded less.
- PE mulch rated the highest in PVI (Figs. 3 & 4).
- Cellulose-based mulch tore and blew away due to weather during the 2015 growing season. It was replaced and held in place with a layer of soil.
- In 2015, the corn starch BDM remained most intact of the BDMs, while the cellulose-based mulch deteriorated the quickest due to weathering.
- Fruit quality, chemical migration, and in-soil biodegradation data ongoing.

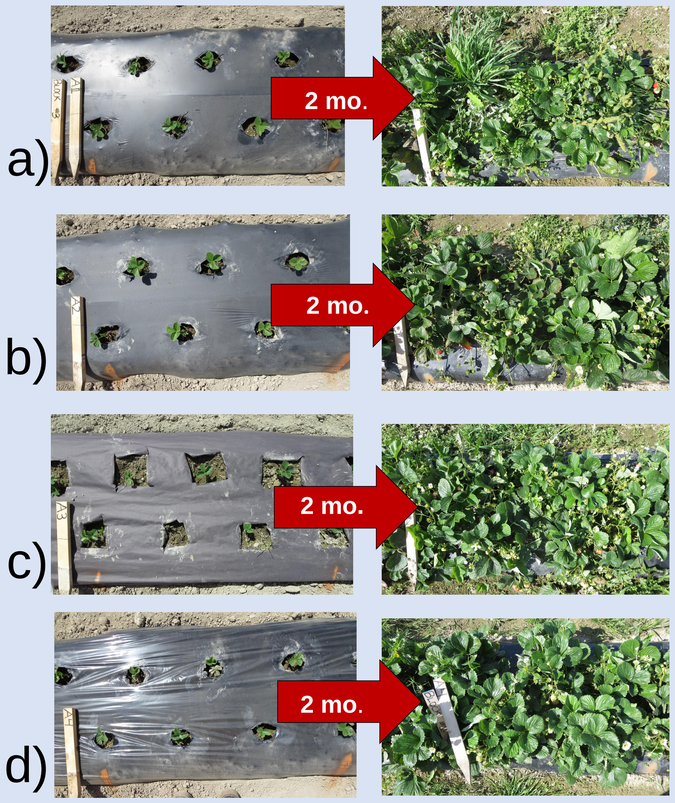

Figure 4. Percent Visual Intactness (PVI) and weed coverage after two months. Images on the left and right were collected 15 June and 15 Sept., 2015, respectively. a) Corn starch-based BDM; b) Prototype fermentation product BDM; c) Cellulose-based BDM; d) Polyethylene (PE) mulch.

CONCLUSION

BDMs appear to be a suitable alternative to PE mulch in a plasticulture system for day-neutral strawberry production in western Washington. More data will be collected to further determine the safety of BDMs and their suitability for organic systems. Future research should focus on use in other crops, biodegradation in different climates, as well as longer term studies to evaluate the role BDMs have on soil quality.

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